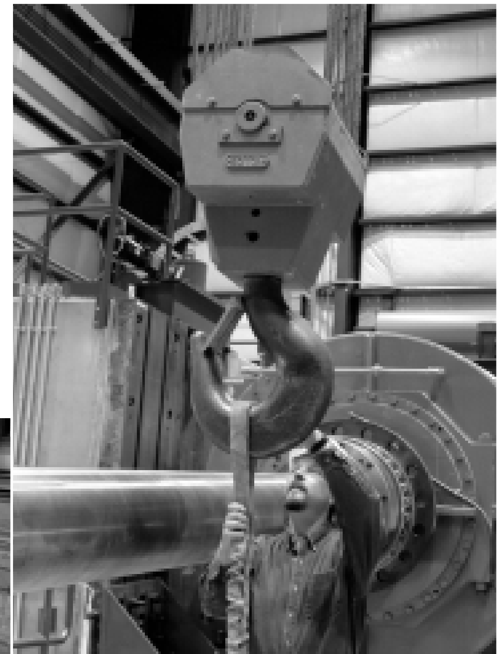
Dynamometer Test Bed

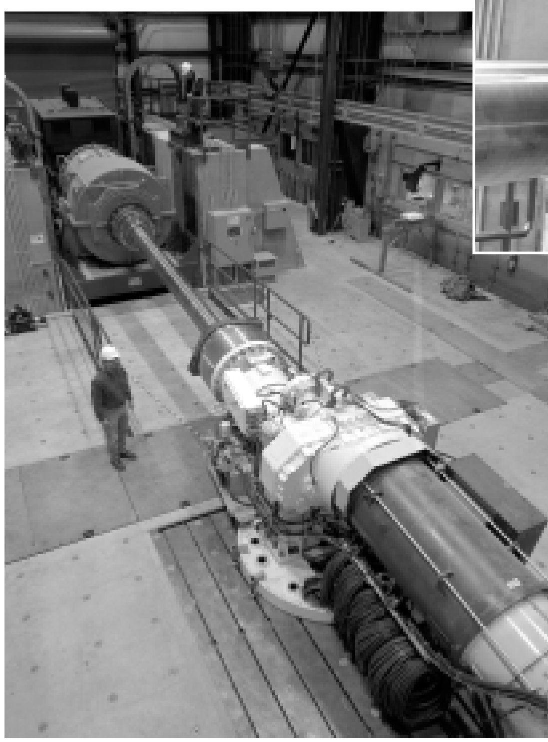
The National Renewable Energy Laboratory's (NREL's) Dynamometer Test Bed is one of a kind. It offers wind industry engineers a unique opportunity to conduct lifetime endurance tests on a wide range of wind turbine drivetrains and gearboxes at various speeds, using low or high torque. Located in a 7500-ft^2 building at the National Wind Technology Center near Boulder, Colorado, the 2.5-megawatt (MW) Dynamometer Test Bed was developed to help researchers improve the performance and reliability of wind turbines and ultimately reduce the cost of the electricity they generate. By testing full-scale wind turbines, engineers from NREL and industry hope to understand the impact of various wind conditions with the goal of improving hardware designs.

Wind turbine designers are working to increase the field lifetime of wind turbines by decreasing the loads on components or by making the components more resistant to wear. Wear on drivetrains is an important factor in turbine reliability. Drivetrains contain many components that work together as a system. Each of these components is the subject of design and manufacturing improvements that can be tested on the dynamometer.



Warren Gretz, NREL/PIX08570

A 50-ton electric bridge crane operates 30 feet above the test table to move the large test drivetrains into position.



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Dynamometer Test Bed offers industry engineers a unique opportunity to conduct lifetime endurance tests.

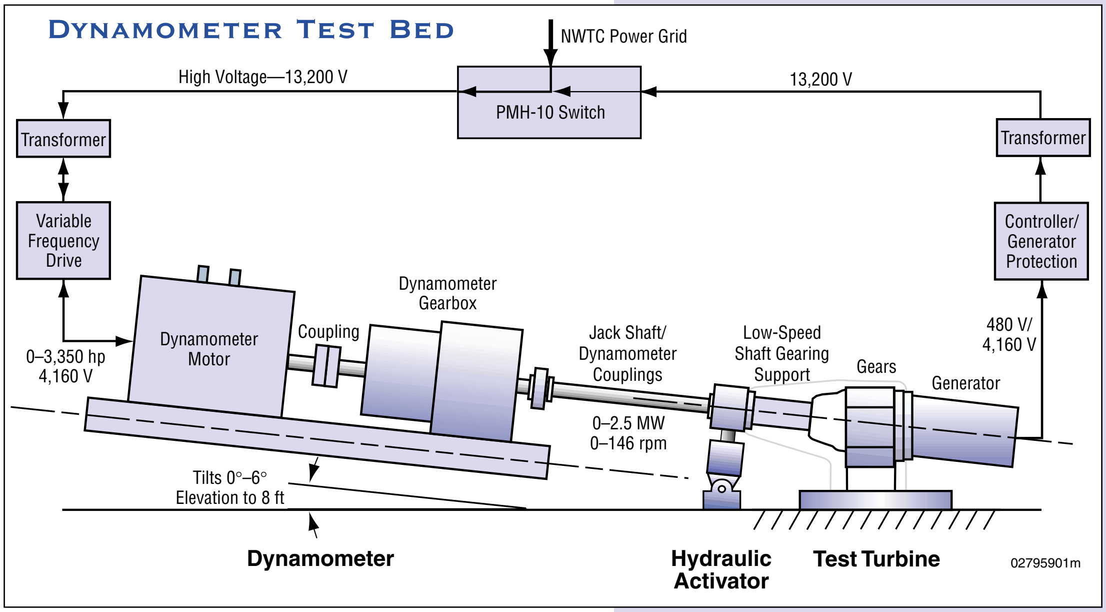
A few months of endurance testing on NREL's Dynamometer Test Bed can simulate the equivalent of 30 years of use and a lifetime of braking cycles, thus helping engineers to determine which components are susceptible to wear. These endurance tests require several months of continuous unattended operation. The test bed's sophisticated Supervisory Control and Data Acquisition (SCADA) System monitors the critical test parameters and can shut down the test if abnormal conditions are detected.

In addition to testing turbines from industrial partners, the new test bed will be used to test prototype turbines from the DOE Turbine Development Program. These tests will confirm the benefits of new approaches and identify problems for redesign well before machines are deployed for field testing.

NREL's Dynamometer Test Bed includes a powerful 3,350-horsepower (hp) electric motor coupled to a 2.5-MW, three-stage epicyclic gearbox that can produce variable speeds from 0 to 146 revolutions per minute (rpm) and run at torque levels up to 9.6 million inch-pounds to simulate the effects of various wind conditions. Its flexible design allows it to couple with the shaft position of any wind turbine system from 100 kilowatts (kW) to

2 MW in size. A 50-ton electric bridge crane operates 30 feet (9.1 meters) above the test table to move the large test drivetrains into position.

In addition to gearboxes and brakes, the dynamometer can test all the other components of the drivetrain—the control system, the generator, the fault logic controls, and more. Tests can also be conducted in conjunction with hydraulic pressure or electric cranes to apply transverse or ancillary loading to a rotating shaft or coupling.



Types of Testing

Gearbox/drivetrain endurance testing—Endurance testing demonstrates the fatigue life of a particular gearbox. Testing conditions require high steady-state power levels that vary from 1.3 to 1.8 times the rated capacity of the test article and the test must run for several months of continuous unattended operation. Endurance testing may also require the application of significant transient load cycles that are part of a long-term operating spectrum. Transverse shaft loads may also be applied using hydraulic actuators.

Turbulent wind simulation testing—This type of testing demonstrates the proper operation of the wind turbine's control system under design turbulent conditions. Random wind turbulence is translated into shaft torque by a computer algorithm using inputs from the turbine's own controller. Severe stochastic torque conditions are simulated demanding that the turbine system perform at its limits.

Transient load testing—Transient load testing applies extreme transient torsional loading to the drivetrain or drivetrain components by applying the system's own brake or starting system. System inertia is matched by using the regenerative power system of the electric variable-speed drive. Transverse loads may be applied to driveshafts, bearing housings, or yaw systems to re-create extreme wind load design cases.

Direct-drive (low-speed) generator testing—This type of test uses a direct connection between one of the output driveshafts and the generator. The dynamometer test bay has a pit built into the floor to accommodate generator designs that may have an oversized radial dimension. In these instances, part of the generator may be dropped in the pit below the surface of the test bay floor to facilitate proper alignment of the shafts.

High-speed generator testing—A high-speed generator test is conducted by directly coupling the test article to the north-pointing shaft end of the drive motor. Tests of this kind may be run continuously and unattended.

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